SALT NEWS

(for public distribution)

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Sunset at SALT: Janus Brink

SUMMARY

This issue presents some recent SALT results, namely spectroscopy with the Robert Stobie Spectrograph of two galaxies, and fast photometry of near Earth objects. Evidence for a dark matter halo surrounding a polar ring galaxy is presented by Alexei Kniazev (SAAO) and Noah Brosch, while Petri Vaisanen (SAAO) and collaborators have studied an interesting luminous IR galaxy undergoing a merger. Tomek Kwiatowski and his group from the University of Torun, Poland, have determined the spin period of a sample of nearby rapidly rotating asteroids.

SALT continues to be faced with two major technical challenges, namely the poor imaging performance of the telescope and the low throughput of the Robert Stobie Spectrograph (RSS). While the cause for the latter has been identified and the problem is nearly solved, progress continues on diagnosing the cause(s) of the image quality problems.

Other aspects of the telescope have benefited considerably from the engineering efforts of SALT Technical Operations team. These activities can be best described as "completion" tasks, which have involved a significant amount of effort to ensure the efficient operation of the telescope. Virtually all of the major telescope subsystems have been scrutinized, with the result that the telescope now performs to its operational specifications in most areas. During the early operations of the telescope, a number of small, but irritating, design defects were uncovered. Examples include the glycol coolant piping, dome mechanics, the mirror lifting crane and water leaks from the dome and louvers. All of these have been, or are being addressed, as part of the on-going engineering work.

Since RSS was removed from the telescope in Nov 2006, for its repair, the only available science instrument has been the imaging camera, SALTICAM. Although image quality work has taken priority over science observations, we have nonetheless undertaken some SALTICAM observing programs, and continue to do so.

Activities which are scheduled to take place over the coming months include the removal and recoating of the primary mirror segments. Coordinated with the recoating program will be the commissioning of the CO_2 mirror cleaning system, which will be used to clean the primary mirror at a frequency of at least every ~2 weeks. Once the optical problems with the telescope are solved, it is planned to install both the atmospheric dispersion compensator (ADC) and moving pupil baffles. The latter, in concert with the mirror cleaning regime, should significantly reduce both the stray and scattered light problems. Finally, a new autocollimator system, avoiding the use of the 670 nm laser source which causes so much stray light, particularly in the R-band, is being investigated, together with ways of better baffling this light source.

ASTRONOMY OPERATIONS

The SALT Astronomy Operations division has continued to make progress in various astronomy operational areas. Since the end of 2006, various outstanding and ongoing tasks have been identified and responsibilities assigned to SALT Astronomers. These tasks are discussed and reviewed at weekly meetings. The activities include supporting the characterization of the telescope, instruments and detectors. In addition, various software tools have been developed to assist in data handling and primary reductions. A start has also been made on the data reduction pipeline, which is being written in Python & Pyraf, and will eventually be released to the SALT community. Significant progress has also been made with the SALT Principal Investigator Proposal Tools (PIPT), used to write observing proposals and monitor progress. Crucial to the efficient performance of the telescope is the Observatory Control System (OCS), which translates the observational details residing in the Science Database (SDB) into configuration (telescope and instrument) setups. Good progress has also been made on this, the SDB and the scheduling software (a.k.a. the Observation Planning Tool, or OPT). An improved interface to the latter was recently completed.

As stated elsewhere, the priorities for night-time work since the last SALTeNEWS (Nov 2006) has been the ongoing diagnosis of the image quality (IQ) problems. In addition, in recent months we have been allocating bright Moon weeks for general engineering work. This is partly to accelerate progress on the remaining completion tasks, but also to allow the technical staff to undertake activities that potentially takes the telescope off-the-air for nights at a time. Due to the very dusty nature of the primary mirror segments, scattered light is a big issue during bright Moon time, and so sacrificing such weeks is not seen as having a serious science impact.

Below is a tabulation of the nighttime statistics for the period since the last SALTeNEWS to the present. The increased engineering usage has been almost entirely due to the IQ campaigns. A two-week engineering stand-down starting in late May, and an engineering week in July, were not included in the current statistics. Faults which take the telescope down during useable night-time hours have generally decreased to meet the specification, although two events involving the dome, which meant 3 lost nights, drove this figure up for May. The weather over this 11 month period has also been systematically worse than the long-term average.

Quantity	***Spec***	***Oct 06***	***Nov 06***	***Dec 06***	***Jan 07***	***Feb 07***	***Mar 07***	***Apr 07***	***May 07***	***Jun 07***	***Jul 07***	***Aug 07***
Out of total time:												
Science:	65%	34%	24%	18%	31%	20%	32%	20%	37%	15%	17%	3%
Bad Weather:	25%	49%	37%	39%	27%	28%	35%	35%	35%	18%	30%	52%
Engineering:	7%	12%	31%	37%	39%	50%	32%	43%	16%	67%	47%	45%
Faults:	3%	5%	8%	6%	3%	2%	1%	2%	12%	0%	6%	0%
Out of potential observing time (i.e. spectroscopic or better conditions):												
Science:	87%	68%	37%	29%	42%	28%	50%	32%	56%	19%	25%	6%
Engineering:	9%	22%	49%	61%	53%	69%	49%	66%	25%	81%	67%	94%
Faults:	4%	10%	14%	10%	5%	3%	1%	2%	19%	0%	8%	0%

All figures rounded to the nearest percent.

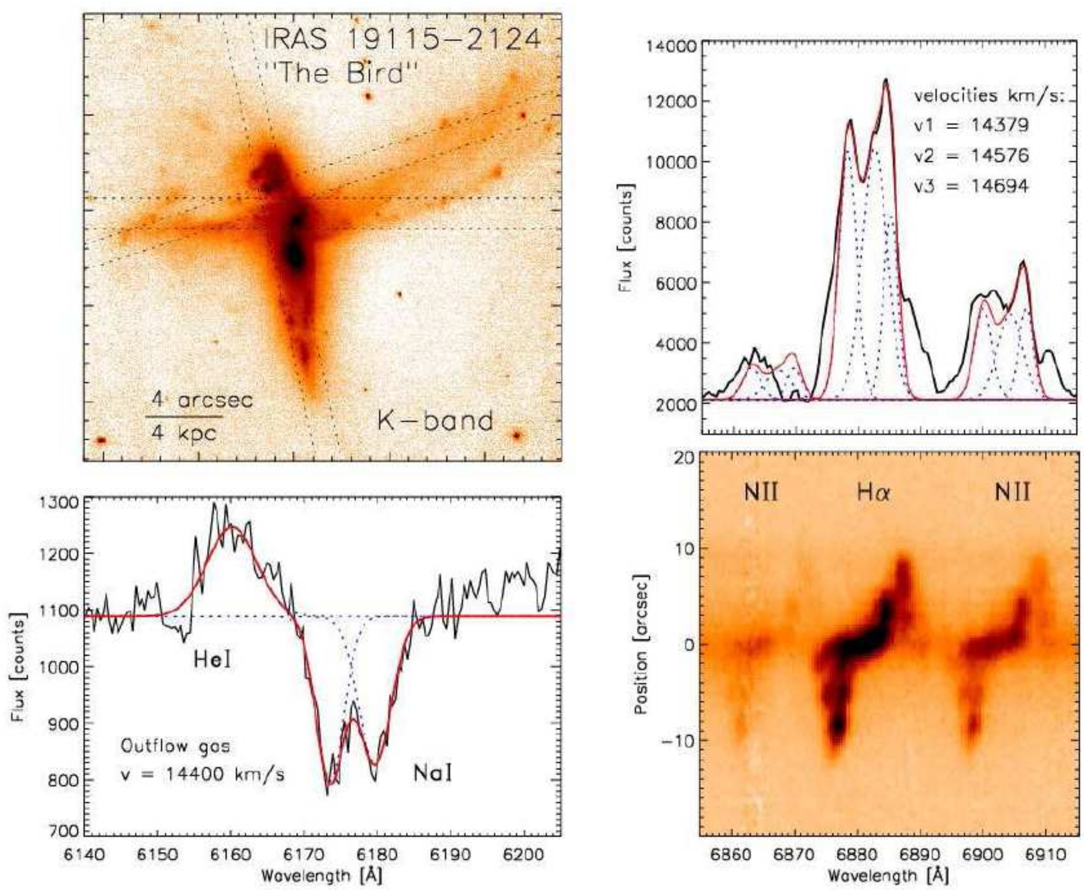
SALT SCIENCE

The following articles are based on SALT observations. SALT users are encouraged to submit articles based on SALT data to the editor at any time.

1. The Bird: The dynamics of a multiple merger in a luminous IR-galaxy.

SALT spectroscopy was used by Petri Vaisanen and Alexei Kniazev (SAAO), Seppo Mattila (Turku), and others, to study the past, present, and future of an interacting luminous IR-galaxy (LIRG) IRAS 19115-2124. The RSS PG1800 spectra were combined with VLT adaptive optics NIR imaging, HST/ACS imaging, and Spitzer imaging and spectroscopy. This comprehensive data-set revealed a rare case of a massive triple merger of gas-rich components on its way, it is assumed, to becoming an elliptical galaxy in the future. The spectra, with velocity dispersions, rotation curves, and line strengths, allowed the determination of the dynamics and kinematics of the system, mass estimates of each component, as well as star-formation and physical characteristics.

Because of its appearance in I and K-band, the system was dubbed the Bird, the tidal tails, extending 20 kpc, making the 'wings' and the 'tail' of the creature. High-resolution NIR imaging together with the spectra revealed two massive spiral galaxies in the 'body' of the Bird; the 'head' turned out to be the least massive component. However, it is this latter component which dominates the star formation output (190 $M_{\odot}$/year) of the whole system. The 'head' component has a radial velocity offset of nearly 400 km/s to the more massive nuclei. Comparing to numerical simulations, it seems likely that the observations have caught the action right at the moment of the first high-speed fly-by of the 'head', associated with a starburst, while the other nuclei are further into their merger sequence, but before their second star formation peak and final coalescense. The Bird, at a redshift of z=0.05, will be an excellent laboratory to study in detail galaxy transformational processes that are both relevant and poorly understood at high redshift.



The upper left panel of the figure shows the VLT/NACO image (the resolution is 0.09 arcsec FWHM), with the three RSS slits that were used overlaid. Lower right is a cut-out of one of the 2D spectra around the observed Hα region showing the very complicated velocity structure. Above it at right, the panel shows the extracted spectrum in a 1.5 kpc aperture, along with a three-component velocity fit. The bluest wing of the fits show line ratios typical of shock-heating, suggesting gas outflows. Indeed, NaI D absorption doublets were detected from the spectra as well (lower left panel) with blueshifted velocities in the range 100-300 km/s. (reference: Vaisanen et al., submitted to MNRAS, Astro-ph:0708.2365)

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2. A Polish PV program: photometry of small, fast rotating asteroids

Most of the smallest asteroids (diameters < 150m) are known to display very short period light variations (from several minutes to 1-2 hours). They form a separate population of bodies believed to be monolithic rather than loosely bound rubble piles. The study of these objects can help to understand the composition of asteroids where the forces of cohesion and gravitation come into play.

Starting from 10 January 2007 we have conducting a photometric survey of the smallest asteroids with SALTICAM. Our proposals are submitted as "target fillers" and are executed in an ad hoc manner. This is very important because the smallest asteroids reach a sufficient brightness of 18-21 mag only when passing near the Earth. Most of our targets are newly discovered bodies with typical observing windows of several days to two weeks and their ephemerides are often updated, which means finding charts must be prepared on a night-by-night basis (till now we have prepared more than 200 such charts!).

As our targets often have periods as short as several minutes, the exposure times are typically 15-30 s through the SALTICAM V-S1 filter. The lack of proper flat-fielding at present is only a minor problem as most of our objects have large amplitude of light variations.

On several occasions we missed the ability of non-sidereal tracking rates (which will eventually be available: ed) because our targets can have sky motions as big as 10 arcsec/min and more. In such cases, when the asteroids were bright enough, we could still observe them by shortening exposure times to 5 s to avoid trailed images.

The faintest object observed so far had brightness changes of V=20.5-21.5 mag and a large sky motion which forced us to use 5-10 s exposure times. To reach sufficient S/N we used the C-S1 ("clear") filter which gave us much more light, but lots of contaminating light 'features' caused by the autocollimator. However, during time spans as long as 10 minutes these 'features' remained quite constant and did not cover the images of the asteroid or the comparison stars. The light curve obtained for this target revealed a period of 164s (or its harmonic) which showed that longer exposure times would not be useful anyway.

Our observations were conducted under a wide variety of conditions, with seeing sometimes as high as 3-4" and during bright Moon time. We have learned that the CCAS tower (in the ENE direction) can sometimes obscure part of the mirror and during bright time it can produce nasty reflections when observing targets close to it in the sky. It would be good to include this obstacle in the visibility calculator.

On one occasion we discovered one of our check stars displayed quasi-sinusoidal light variations. It appeared it was a star-like ghost reflection and we found several other such "objects" in the field of view. They occupy constant positions in the frames (stars do move a bit due to the lack of an autoguider) and can be found by blinking the images.

Until now we have obtained light curves for 20 asteroids and periods of rotation for 12 of them. Two objects were found to have non-principal axis rotation (and thus multi-periodic light variations) and for several others periods could not be derived because they were either too long or their light curves had too small amplitude.

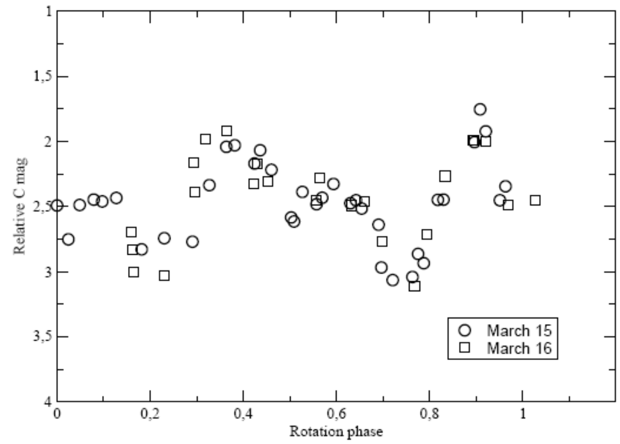


Figure 1: A composite SALTICAM phase binned light curve of a 21 mag asteroid, obtained with a period of 164 s, although its harmonic at 82 s cannot be ruled out. A series of 7 s exposures were obtained through the "clear" filter.

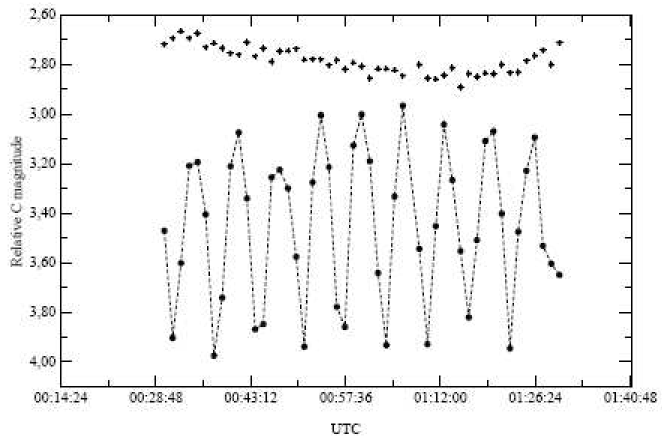


Figure 2: A lightcurve of a 20.5 mag asteroid (black circles), obtained with 60 seconds exposures through the "clear" filter. Note a large scatter of the check star (the top curve), partly due to the lack of proper flat-fielding.

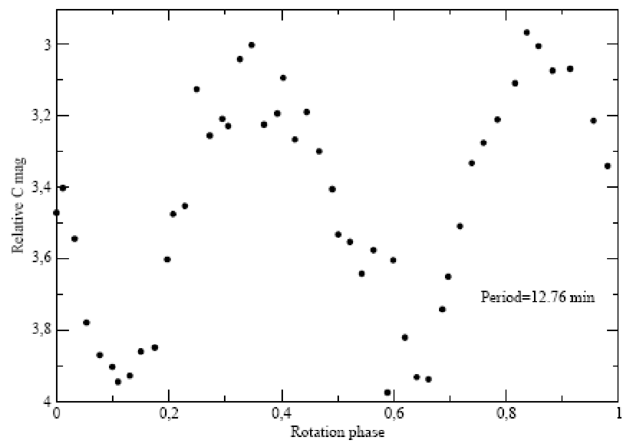


Figure 3: The lightcurve from Fig.2 after folding on the rotation period of 12.76 minutes.

Tomasz Kwiatkowski, Agnieszka Kryszczynska, Magdalena Polinska, Astronomical Observatory of Adam Mickiewicz University (tkastr@vesta.astro.amu.edu.pl)

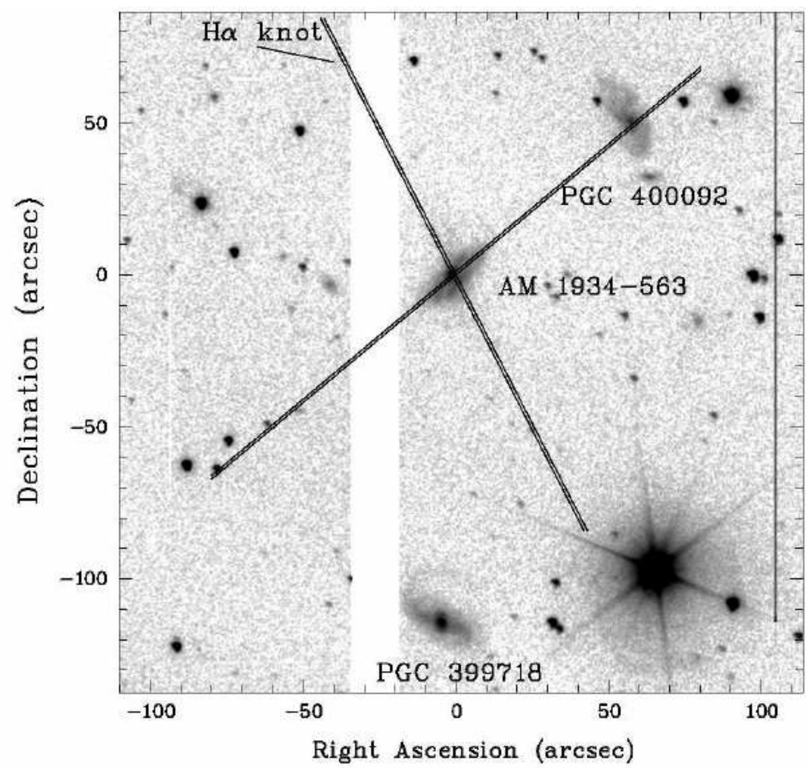
3. SALT unravels the shape of galactic halos

PV observations with RSS allowed us to establish that the galaxy AM1934-563 has a dark matter (DM) halo that is flattened in the direction of the equatorial plane of the galaxy. This is the first object that shows this behaviour of the dark matter (DM).

Some controversy can be found in the literature as to whether the DM is fully decoupled from regular matter, or whether some interaction between the two might be possible. As part of the PV observations with RSS, we performed long-slit observations of this “Polar Ring” galaxy with the goal of characterizing the kinematic properties along the major axis and perpendicular to it, along the polar ring.

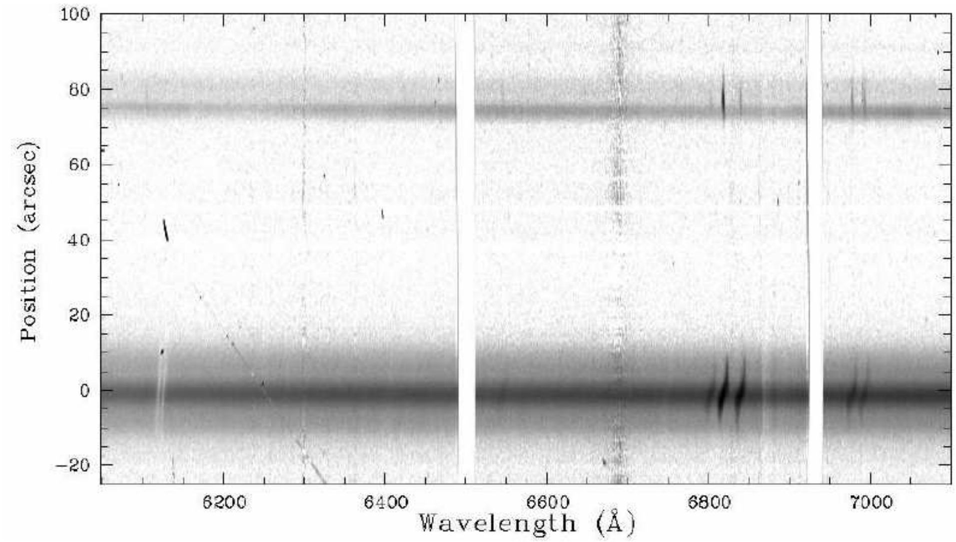
Polar ring galaxies (PRGs) have been known for some 20 years and their rings are understood as results of accretion onto an existing galaxy. The matter may have been part of a disrupted galaxy or may accrete from intergalactic space. The important detail is that, at least in the first stages (a few hundred million years) following the accretion event, the ring material usually follows orbits in different planes than the material in the main galaxy.

AM1934-563 has a polar ring that orbits in a plane that is almost perpendicular to that of the main galaxy. Yet, if we believe the accepted scenario of galaxy structures, both ring and galaxy orbit in a larger DM halo. By carefully mapping the velocity field of the galaxy and of its polar ring as functions of distance from the galaxy center, one may derive the shape of the DM halo. Diagnostics predicting different behaviours for different halo shapes, with specific application to PRGs, have been published by Combes and collaborators.



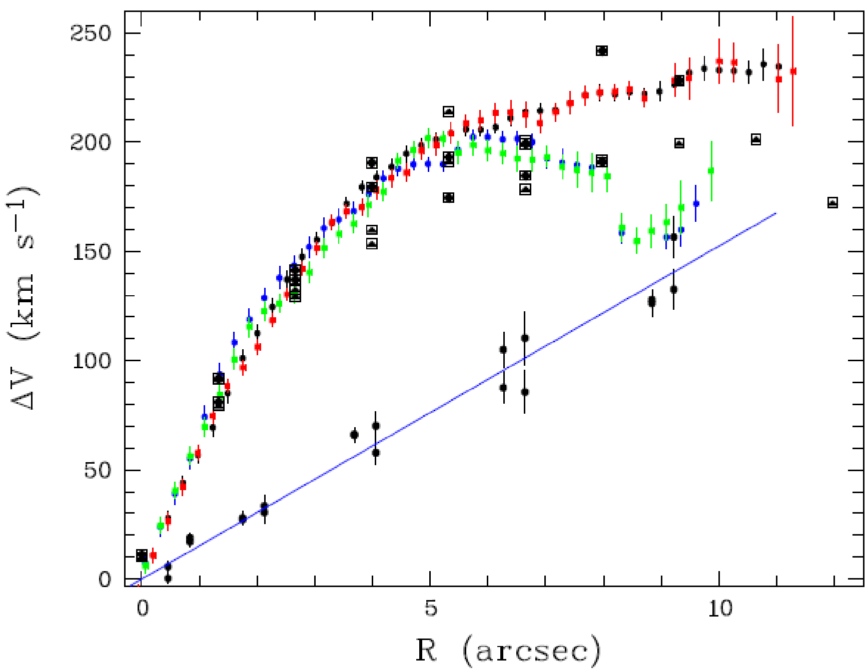
A 220 x 220 arcsec image of the AM 1934-563 region extracted from a 2 sec exposure with SALT. The three galaxies of the tight group are indicated, as is a newly detected H-alpha knot at the same redshift as the target galaxy. The slit positions used here are over-plotted and each slit is 1.5 arcsec wide.

We obtained long-slit spectra with the RSS along the major axis and along the axis of the polar ring to determine the velocity of the material there. The measurements were of emission and absorption lines. The absorption lines, from Na I, show solid-body rotation since their gradient vs. distance from the galaxy center is constant. This might be the signature of a bar in the main galaxy, but could also be produced by very thick interstellar dust in AM1934-563.



Part of the long-slit spectrum along the major axis showing the H, [NII] and [SII] emission lines and the Na I absorption doublet. The spectrum of the galaxy is visible for about 15arcsec. The spectrum of the neighbouring Sd/Irr galaxy PGC 400092 is about 80 arcsec away. At the adopted distance of 167 Mpc, 1 arcsec = 0.8 kpc and the image extent is about 100 kpc.

The results show that then polar ring rotates slower than the galaxy at similar distances from the center. This indicates that the halo DM is more concentrated toward the galaxy than toward the ring, and does not have a spherical shape or is concentrated toward the polar ring, as seen in other PRGs.



The galacto-centric velocity distributions along the major axis of the galaxy. The black and red filled circles are for the emission lines of H-alpha and [NII] lines to NW of the centre; the blue and green filled circles are for the same lines on the SE part of the galaxy. The filled black circles show the velocity from the Na I absorptions and the solid blue line is a linear fit for these lines.

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SALT PROPOSAL TOOLS

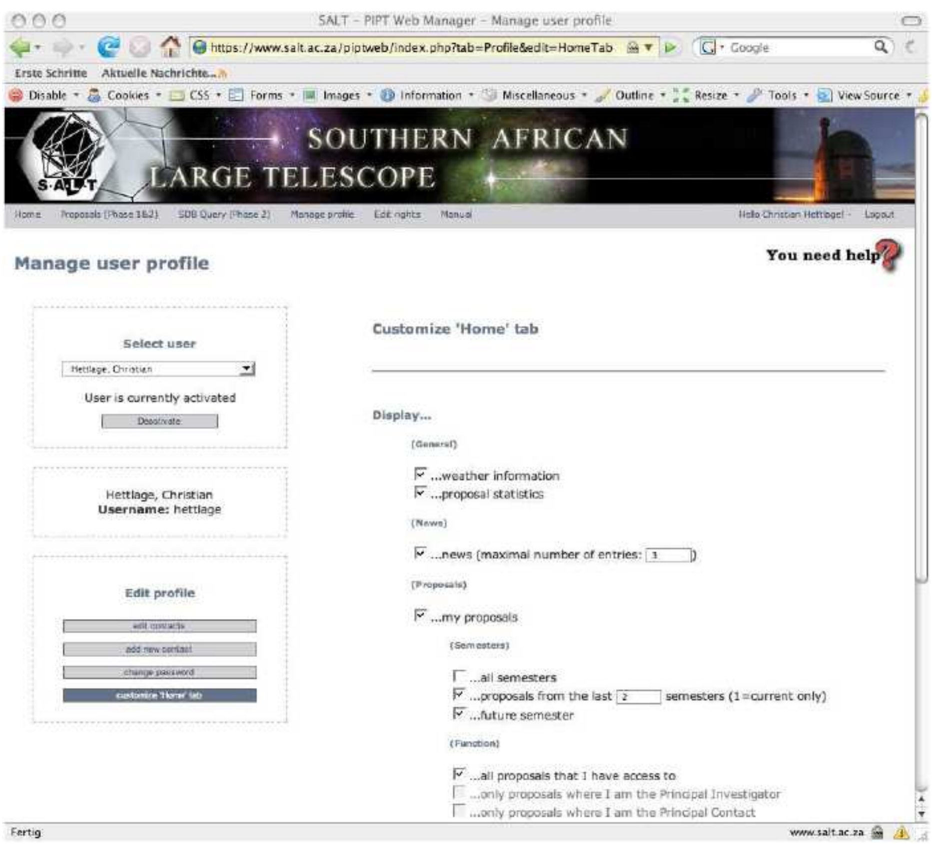
In order to allow creating proposals which make use of the Robert Stobie Spectrograph (RSS), the PIPT Manager is currently undergoing a major overhaul. Even though the RSS will add quite a bit of complexity to the proposals, creating them should be more intuitive with the upcoming Manager version. And of course additional functionality is planned:

- Re-use of existing information is facilitated, as proposal content can be moved or copied by drag-and-drop within a proposal or even between different proposals.
- In order to decrease the cardiological risk posed by accidentally deleting content you had been working on for ages, undoing past operations is possible.
- On a similar note, auto-saving is provided.
- If you know a target name but not the corresponding coordinates, you may automatically query Simbad to fill in the gaps.
- Throughout the proposing process you have direct access to the relevant sections of the online manual.
- The Target Visibility Tool, the SALTICAM Simulator and the RSS Simulator are integrated into the PIPT Manager. (But you may still use them as stand-alone tools, if you prefer.)
- Whenever you get a cryptic error message and want to ask for help or just want to report it, you can directly create an e-mail containing the error information.

The release of the next PIPT Manager version is scheduled for the Board Meeting in October.

Similarly, support for RSS observations is currently being added to the PIPT Web Manager and should be included in its next release. In the meantime, you may enjoy a new feature which has been added in its latest version, released in August. If you log in (at https://www.salt.ac.za/piptweb) and choose "Manage profile" from the menu, you can now customize the "Home" tab you see after logging in. After all, you probably know better what you need than we do! And, as usual, if you feel something is missing or could be improved in the PIPT software, please feel free to let us know by sending an e-mail to salthelp@saao.ac.za.

Christian Hettlage, SALT/SAAO (hettlage@saao.ac.za)



SALT DATA PIPELINE

The SALT reduction pipeline has undergone a transformation! In some of his last work as a SALT Astronomer, Martin Still has updated the SALT pipeline, formerly based on the IRAF environment, to a powerful PyRAF algorithm driven by Python. The new pipeline performs the basic SALT reductions in a reliable and flexible manner. This change follows the decision by the SSWG to adopt PyRAF as the preferred data reduction system for the SALT community. It is also seen as meeting the challenge of developing a true comprehensive ground-based telescope data pipeline, championed by SAAO Director, Phil Charles. Now that the new pipeline has replaced the old shell-based one, we are hoping to further develop the reduction tasks so that quality reduced data is quickly delivered to the observers.

The new pipeline was developed primarily to meet the challenges faced with the SALT data reductions. A fundamental challenge of the pipeline is to rapidly reduce the large amount of data produced by the telescope in a slew of different modes. The IRAF environment was not capable of meeting these needs especially for data with high time resolution. The SALT software team has adopted PyRAF as the language of choice for the pipeline. Developed by STScI, PyRAF is a scripting language that allows users to run IRAF task and develop new tasks in Python. The new pipeline is able to rapidly reduce SALT data. For example, the new pipeline is able to reduce 50,000 slot mode images in an hour whereas the old pipeline was more than an order of magnitude slower. Furthermore, the flexibility of the Python/PyRAF environment allows for the future development of powerful tools to handle any reduction tasks.

Now that the basic reduction suite is in place and the environment for software reductions has been decided, the SALT software team can focus on further development of the pipeline to better meet the needs of the partners. Some basic reductions still need to be included in the pipeline, but the goal in developing the pipeline is to produce high quality SALT data that are ready for scientific analysis. Please feel to contact salthelp@salt.ac.za for suggestions, volunteer to help, or make any additional comments.

For more information, please visit:
http://www.salt.ac.za/partners-login/partners/data-analysis-software/
http://www.stsci.edu/resources/software_hardware/pyraf
http://www.python.org/

Steve Crawford (crawford@saao.ac.za)

NEW SALT PARTNER INITIATIVES

The Board of Directors is pleased to announce the addition of two new members to the SALT partnership. The American Museum of Natural History (AMNH), of New York, and the Inter-University Centre for Astronomy and Astrophysics (IUCAA), of Pune, India, have now both formally joined as SALT partners. In return for their financial investment and the contribution of their skills and knowledge, the new partners will gain access to observing time on SALT.

Meeting at IUCAA (Pune, India) on 10 Dec 2006.

Both institutes employ world-class astronomers ready to exploit the capabilities of SALT. Research at the AMNH focuses on the formation and evolution of stars and star clusters and on the effects of stellar radiation and supernova explosions on interstellar and intergalactic gas. The Museum also has scientists with extensive expertise in the field of adaptive optics and coronagraphy. In addition, AMNH brings its world renowned expertise in public outreach and popularisation of science to the SALT project. Plans to develop SALT-specific public materials will be to the benefit of all partners.

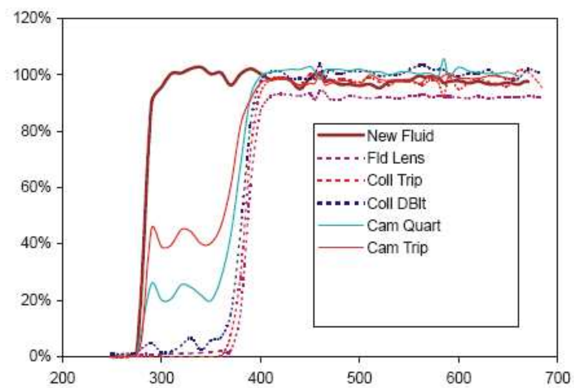
Astronomers at the IUCAA conduct a wide range of astronomical research in areas as diverse as solar physics, stellar physics, cosmology and studies of the large-scale structure of the universe. It is hoped that joint research initiatives exploiting the capabilities of SALT and the Indian Giant Metrewave Radio Telescope (GMRT) will arise from the participation of the Indian research community in SALT.

Last December and January saw the SALT 'road show' take to the air when Ted Williams (SALT Board Chair), Phil Charles (SAAO Director) and David Buckley (SALT Project Scientist) visited both IUCAA and Tel Aviv University (TAU), Israel, to discuss the possibility of them joining the SALT consortium. A positive result was that IUCAA subsequently joined SALT and TAU are still considering whether to join.

ROBERT STOBIE SPECTROGRAPH UPDATE

Since the removal of RSS from the telescope on 16 November 2006, the optics were disassembled and sent back to the USA in order to identify and fix the serious throughput losses. These losses were found to be caused by three separate things:

1. The most serious loss was the UV (< 400nm) absorption seen in the multiplet lenses and caused by contamination of the index matching lens coupling fluid by a non-compatible expansion bladder and o-ring material.
2. A grey loss attribute to the loss of fluid and the contacting of two elements in the camera triplet.
3. A bad multi-layer anti-reflection coating on the field flattener lens, which is also the cryostat window. This resulted in a dip in throughput at ~550 nm and was identified as the cause for the ghost seen in Fabry-Perot images.



A graphic demonstration of the UV losses seen in coupling fluid samples of 1 mm path length extracted from the RSS multiplets. The conclusion is that contaminated coupling fluid is responsible for the UV losses in RSS.

All of these throughput losses have now been, or are being, addressed, and we anticipate receiving the repaired optics sometime in the next month or so. In the meantime there have been various other changes made to the instrument, primarily involving the robustness of the mechanisms and addressing various flexure issues. Improvements have also been made to the control GUI and spare controllers for all of the mechanisms have been fabricated.

Even before the removal of the RSS, SALT Technical Operations initiated the redesign of the Slit Mask Mechanism to address reliability problems. The problem was that the interlock system could not detect when a slit mask was not properly positioned for safe movement of the elevator stage. So when a mask bridged the gap between moving parts the mechanism was seriously damaged, which lead to the redesign. The solution was to improve the mechanical design and to add additional sensors on the elevator stage that will detect when it is not safe to move the mechanisms elevator stage.

Mike Smith, mechanical engineer on the instrument, who had by then already moved over to HET and now based in Austin Texas, fortunately offered to assist with the redesign and did most of the mechanical

CAD design changes. James O'Connor (Cape Town), took responsibility to get the parts manufactured and did the mechanical integration and alignment. Brennan Meyer, Electronic Technician based in Sutherland, did the electronic design and now that Brennan has resigned, Hitesh Gajjar, SALT Electronic Engineer and Charl du Plessis, SALT Electronic Technician (both Sutherland) have taken over responsibility for completing the electronic design and integrating the new mechanism on RSS. Although not fully integrated yet, the project is making good progress and taking into account the distance between various contributors to the design this is set to be a remarkable achievement and a good demonstration of the team work on SALT.

Following a month or so of tests conducted on the ground, in the SALT Spectrometer Room, RSS will then by ready to be lifted back on the telescope. The exact timing for this is yet to be decided, however, since it is somewhat dependent on the ongoing IQ work and whether the SAC will be removed from the telescope for repair.

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SALTICAM UPDATE

For a number of reasons the planned SALTICAM upgrade, or "big fix", has been postponed. The main reason for this was the over-riding need to have SALTICAM on the telescope during the image quality diagnostic work, which continues. It has therefore been decided to de-couple the "big fix" from the other main activities, namely the IQ work and re-commissioning of RSS, once it is re-installed onto the telescope. Since SALTICAM is also the acquisition camera for SALT, it is required for the RSS observations and is therefore unlikely to be removed until this phase has been completed. What could change these plans is the completion of a backup camera for SALTICAM, which could mean SALTICAM's removal would not impact RSS observations.

As most critical SALT subsystems have contingencies for failures, usually in the form of spares, it was decided to develop a simple "spare" for SALTICAM. After all, if SALICAM were to fail, then the telescope would essentially be blind, and would make it very inefficient to acquire targets (we could use RSS in imaging mode). Thus "B-CAM" has been born (where SALTICAM could be considered as A-CAM!), which will be a simple replacement camera system that will be mounted in the existing SALTICAM bay. This camera is based on an Apogee 4k x 4k CCD camera with a simple triplet focal reducer, designed by Martyn Wells. This will give a field of view of ~5 x 5 armin, sufficient for acquisition and allowing the use of the RSS slit-viewing system.

SALTHRS UPDATE

Following the signing of the contract between the SALT Foundation and the University of Durham's Centre for Advanced Instrumentation, a 2-day kick-off meeting was held at the CfAI offices, near Durham, in early August. The meeting was attended by the SALT Project Scientist (David Buckley), Head of SALT Software (Janus Brink), the HRS Optical Designer (Stuart Barnes, University of Texas, Austin) and members of the Durham team, including the Principal Investigator (Ray Sharples), Project Manager (David Bramall), Optical Designer (Jurgen Schmoll), Software Engineer (Colin Blackburn) and the HRS External Project Scientist (Sean Ryan; University of Hertfordshire).

The meeting reviewed various outstanding design issues including the list of recommendations that followed the Critical Design Review completed by the University of Canterbury in 2005. It was decided to implement an additional high resolution observing mode for high precision radial velocities (~1 m/s). This would employ a combination of a fibre double-scrambler and/or an iodine absorption cell. The requirements for high velocity precision were reviewed and it was concluded that athermalizing the spectrograph as much as possible would provide the required stability.

Further work on the mechanical designs is proceeding, primarily producing drawings that are ready for final manufacture. Changes to some of the design aspects are envisaged to improve performance, most notably to the fibre injection system. Monthly status videoconferences have started and a project website will be developed where configured documentation will be available. SALTHRS is due for completion in early 2010.

SALTHRS kick-off meeting, CfAI, 3 Aug 2007. Left to right: Jurgen Schmoll, David Bramall, Sean Ryan, Janus Brink, Stuart Barnes, David Buckley & Ray Sharples.

SALT IMAGE QUALITY

SALT's ongoing image quality (IQ) problems have remained a source of confusion, frustration and considerable ingenuity as creative approaches have been sought by Darragh O'Donoghue, James O'Connor, Herman Kriel and the extended Operations Team to characterize and tackle these issues. The battle was stepped up during the second half of April when John Booth, Chief Engineer at the HET, arrived on the scene to help out.

During that time it was established that the majority of the focus gradient (the most serious aspect of the IQ problem) was a result of the SALTICAM detector plane rotating with respect to the telescope's focal plane when the payload is rotated. The magnitude of the gradient was also found to vary with rho (ρ) angle, implying some form of misalignment of either the ρ-stage, the payload rotating structure (RS) or the various contents of the RS. To eliminate any effects related to SALTICAM's alignment, a new prime focus instrument dubbed "DummyCAM" – John Booth's eyeball - was used to estimate the magnitude and orientation in space (at $\rho = 0°$) of the focus gradient, independently confirmed the presence of the gradient seen previously in both SALTICAM and RSS images.

Another innovative instrument, SPIFFY (Salt Primary Imaging Facility... For You), was commissioned during the April run. Light from an illuminated pinhole at the centre of curvature is imaged by the primary mirror onto a camera. This provides detailed information about the state of the primary – including the status of individual segments – where either hex-burst or out-of-focus images are obtained, which allows evaluation of the quality of the stack and the overall behaviour of the array.

Subsequent to the June run, a new CCD camera has been installed to replace DummyCAM. SPIFFY images were used to verify the integrity of the primary mirror before and after observing severely aberrated images and extensive laser testing has been carried out to investigate the behaviour of the SAC mirrors and the SAC/NRS interface ring as a function of ρ.

While we all wish the IQ problem would Go Away - NOW, one cannot dispute that it has taught us a huge amount about our telescope and forged a remarkable team of people that are absolutely determined to sort this problem out...

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Left: **One of the many strategy-sessions held in the SALT control room during the course of the IQ runs.**
Right: **View from the CCAS dome, looking past the primary mirror alignment gear, down to the tracker and primary array below. A green laser in the tower was used to define the optical axis of the telescope to allow alignment of the glass plate placed at the RSS slit plane (later to be imaged by DummyCAM).**

Left: **Some no-nonsense engineering conducted by SALT Tech Ops Manager, Herman Kriel, preparing "DummyPFIS" for the integration of "DummyCAM". Apologies to the other observers on the plateau that night for the spectacular lighting display out to the north!**

Right: **A Major highlight of the June run: Darragh riding the tracker & thus conquering his fear of heights! DummyCAM (aka John Booth) looms to the right.**